Vol. XI. OCTOBER, 1895. No. 4.

JOURNAL

OF THE

New-York Microscopical Society

EDITED BY

REV. J. L. ZABRISKIE,

28 REGENT PLACE, FLATBUSH STATION, BROOKLYN, N. Y.

CONTENTS.

	PAGE.
I. Micrometry. By EDW. G. LOVE (illustrated)	97
II. A Modern Microscope Objective. By HENRY ORFORD	106
III. Proceedings	111
IV. Publications Received	117

New-York:

PUBLISHED FOR THE SOCIETY,

QUARTERLY.

PRESS OF DOUGLAS TAYLOR & CO.
No. 8 WARREN STREET.
1895.

[Entered at the Post-Office at New-York as second-class matter.]

New-York Microscopical Society.

OFFICERS FOR THE YEAR 1895.

President, – – – – – – – – – – – – Edward G. Love.
Vice-President, – – – – – – – – – – – – Frank D. Skeel.
Treasurer, – – – – – – – – – – – – James Walker.
Recording Secretary, – – – – – – – – – – George E. Ashby.
Corresponding Secretary, – – – – – – – – – – J. L. Zabriskie.

Committee on Admissions.

Henry C. Bennett, George H. Blake, Thomas S. Nedham, Frederick Kato, W. J. Lloyd.

Committee on Publications.

J. L. Zabriskie, Frank D. Skeel, George W. Kosmak, Edward G. Love, H. A. Parmentier.

Regular Meetings on the first and third Fridays of each month, from October to June, inclusive, at 8 P. M., at No. 64 Madison Avenue, New-York City.

JOURNAL

—OF THE—

NEW-YORK MICROSCOPICAL SOCIETY

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS.

PUBLISHED QUARTERLY.

All communications for the JOURNAL, all subscriptions, and all exchanges, should be addressed to the editor, Rev. J. L. Zabriskie, 28 Regent Place, Flatbush Station, Brooklyn, N. Y.

Terms of Subscription:—In the United States, Canada and Mexico, One Dollar per annum, beginning with the January number. In other countries, One Dollar and Twenty-five Cents per annum.

WELLCOME INSTITUTE LIBRARY
Coll. WelMOmec
Coll. No.

F. W. DEVOE & CO.,

(ESTABLISHED IN 1852.)

Fulton Street, corner of William Street,

NEW YORK.

ARTISTS' MATERIALS,

OF ALL KINDS,

FINE BRUSHES, MATHEMATICAL INSTRUMENTS,

COLORS, VARNISHES.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. XI. OCTOBER, 1895. No. 4.

MICROMETRY.

BY E. G. LOVE.

(*Substance of some remarks made before the New-York Microscopical Society.*)

Whoever undertakes any serious work with the microscope is confronted sooner or later with the necessity for some method of determining the actual size of microscopic objects; and it may not be without profit if we briefly review the different methods for ascertaining this.

As we might naturally suppose, the earliest efforts in micrometry consisted in comparing the miscroscopic object with other objects whose approximate size was known or could easily be determined. Thus Leeuwenhoek employed grains of sea-sand of such size that 100 of them, placed side by side, extended one inch. One of the sand grains was so placed that it could be directly compared with the object under the microscope. The same idea was adopted by later microscopists who employed the very small spores of certain plants.

Hooke, as early as 1675, described a method for determining the magnifying power of a microscope. To use his own words:—"Having rectified the Microscope, to see the desired Object through it very distinctly; at the same time that I look upon the Object through the Glass with one Eye, I look upon other Objects at the same Distance with my other bare Eye: by which means I am able, by the Help of a Ruler divided into Inches and small Parts, and laid on the Pedestal of the Microscope, to cast as it were the magnified Appear-

ance of the Object upon the Ruler, and thereby exactly to measure the Diameter it appears of through the Glass; which being compared with the Diameter it appears of to the naked Eye, will easily afford the Quantity of its being magnified."

While Hooke referred to the determination of the magnifying power, and that with objects capable of being measured without the aid of the microscope, the same method is applicable to ordinary micrometer work.

Dr. James Jurin wound a piece of very fine silver wire about a pin, leaving no space between the threads, measured any length of the coil, and then by counting the number of threads found the diameter of the wire. This was then cut into small pieces and one of them was placed upon or near the object to be measured and a comparison made. That this method was very crude is evidenced by the fact that Jurin found the diameter of a human blood corpuscle to be $\frac{1}{1940}$ of an inch.

In 1742 Benjamin Martin described an eye-piece micrometer which consisted of a screw having fifty threads to the inch. One end of the screw was pointed, while the other carried a hand which passed over a dial divided into twenty parts. This appliance doubtless gave fairly accurate results, and in a more or less modified form has appeared in later micrometers.

Baker also credits Martin with a glass micrometer having parallel lines $\frac{1}{40}$ of an inch apart and placed in the focus of the eye-piece.

Geo. Adams, Sr., in his Micrographia, 1746, says that acting upon the idea suggested by Jurin he constructed a micrometer which consisted of small silver wires stretched in the form of a lattice, the distances between the wires being equal to the diameter of the wire which was probably from the $\frac{1}{500}$ to the $\frac{1}{600}$ of an inch. This lattice was used upon the stage, being placed under the object if it was transparent and over it if opaque. Adams, however, appreciated the difficulty of measuring objects which were less than the diameter of the wire.

Three years prior to Adams' publication, Baker described a similar arrangement invented by a Dr. Smith consisting of a

lattice of fine wires or small squares drawn upon glass with a diamond. This, however, was designed as an aid in drawing microscopic objects.

According to Baker, Cuff devised a micrometer in 1747 which consisted of a lattice of fine wires $\frac{1}{50}$ of an inch apart,

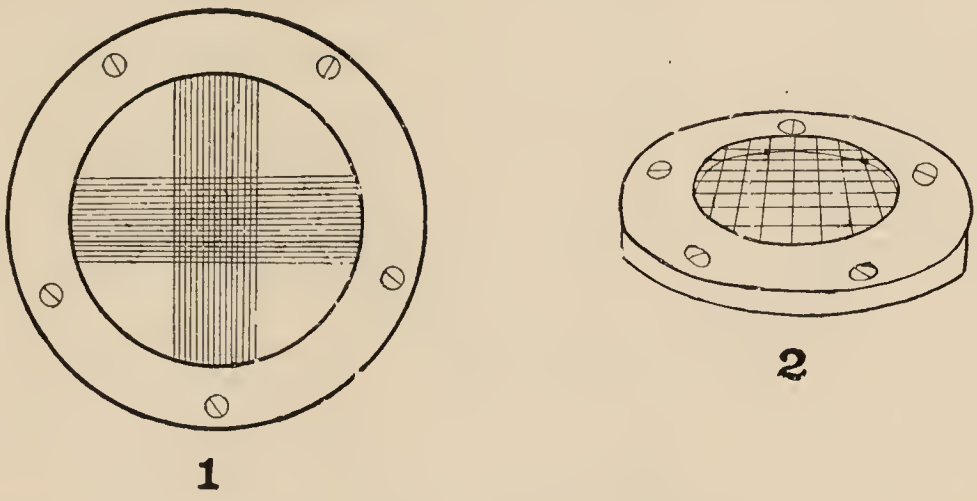


FIG. 1. CUFF'S WIRE MICROMETER.
FIG. 2. BAKER'S HAIR MICROMETER.

set in a circular frame to be placed in the focus of the eye-piece. This device is shown in Fig. 1. Baker made a similar micrometer of human hairs placed $\frac{1}{10}$ of an inch apart, Fig. 2.

Geo. Adams, Jr., in his "Essays on the Microscope," describes a needle micrometer which he states was first made by

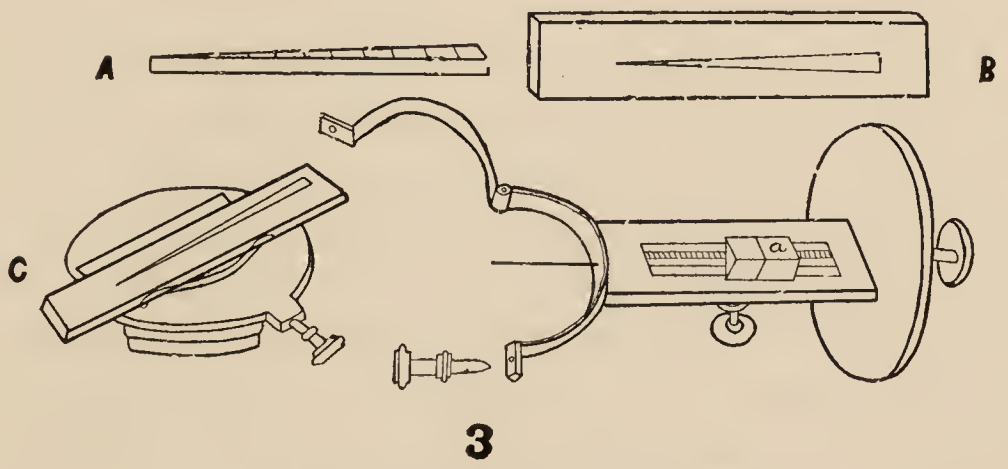


FIG. 3. ADAM'S NEEDLE MICROMETER.
A, B, C. THE SECTIONAL SCALE.

his father. This is shown in Fig. 3. It was designed to be clamped to the tube of the miscroscope, the needle passing through a small opening in the eye-piece. The screw had fifty threads to the inch, and was provided with an index moving over a circular plate divided into 20 equal parts so

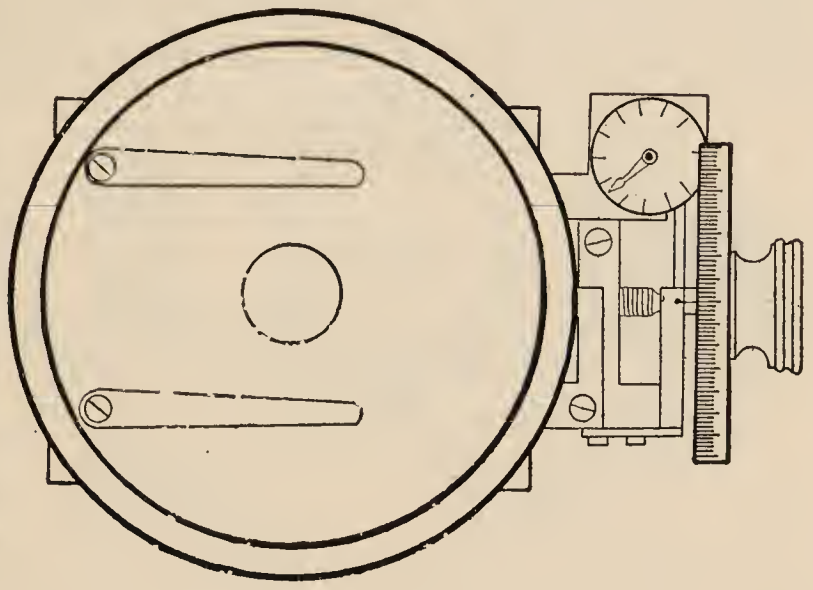
that each division of the scale indicated $\frac{1}{1000}$ of an inch. The small prism, *a*, served to register the number of revolutions. Figs. 3, A, B, and C, show a sectoral scale used upon the stage to determine the actual value of the revolutions of the screw. It was two inches long and $\frac{1}{10}$ of an inch at the base. Hartnack devised a diagonal scale on the same principle which consisted of fifty vertical lines crossed by two horizontal lines whose distance apart equalled five divisions of the vertical scale, and which was crossed by a diagonal. Thus if the length of the vertical line was 0.5 inch, the shortest line on the lower side of the diagonal would be 0.01 inch.

Micrometers may be divided into two general classes; 1st, stage micrometers, in which both object and micrometer are magnified together; 2d, eye-piece micrometers, in which the scale is applied to the magnified image of the object. In the latter class the scale, or micrometer proper, is usually made a part of the eye-piece so that the whole becomes a micrometer eye-piece.

Stage Micrometers. These in their crudest form are represented by the sand grains of Leeuwenhoek and the silver wires of Jurin. The micrometers of Coventry were made of glass, metal, ivory, etc., and bore lines ruled with a diamond at some uniform distance apart. The use of these micrometers for the direct measurement of microscopic objects was of necessity very limited, being confined to low powers where the object and scale could be brought practically to the same focus. In other ways, however, these micrometers are very important. Their use with the camera lucida and in standardizing eye-piece micrometers is familiar to all microscopists. In the former case any object drawn can be measured by replacing the object by the micrometer, the conditions remaining the same. If the size of the object drawn is arrived at by dividing the size of the image by the magnifying power of the microscope, the distance from the eye-piece to the surface receiving the image must be 10 inches.

More recently Zeiss has offered a stage screw micrometer shown in Fig. 4. This is intended for the accurate measurement of objects too large for one visual field of the micro-

scope, and can be adapted to the stage of any of the larger stands. The plan of this micrometer is sufficiently evident from the illustration. The small dial registers complete revolutions of the screw, the fractional parts being indicated by graduations on the larger disc whose smallest divisions are equivalent to .002 mm. The screw measures up to 10 mm., or nearly .4 inch.



4

FIG. 4. ZEISS' STAGE MICROMETER.

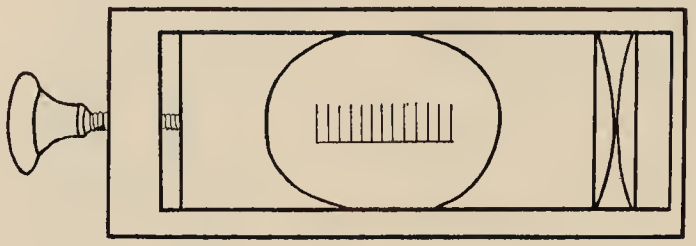
Micrometer eye-pieces. These may conveniently be divided into those with fixed scale and those with movable scale. The eye-piece may be either positive or negative, the former giving the best view of the micrometer, and the latter of the object.

In micrometers with fixed scales, the lines may represent fractional parts of a millimeter or of an inch, or, as is usually the case, be some arbitrary scale, the value of which must be determined for different combinations of objectives, oculars, and tube length. The scales ruled on glass in the form of squares, and which are copied from the lattice micrometers of the older microscopists, are not to be recommended for general work, although they are sometimes used in special cases.

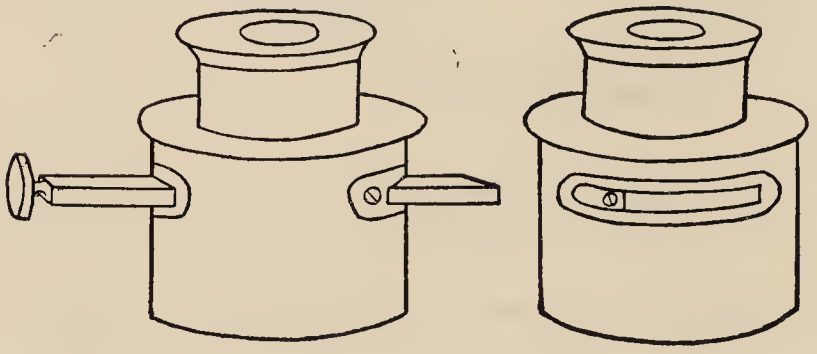
In 1840 Geo. Jackson devised an improved form of Martin's eye-piece micrometer. The scale was on glass and mounted in a metal frame with a screw at one end and a spring at the other. The eye-piece, a negative one, was provided with slits to allow the scale to be moved across the field. The arrangement is shown in Figs. 5 and 6, the former being the micrometer, and the latter its position in the eye-piece.

The method of using this micrometer is familiar to most, but for the benefit of others it may not be out of place to give

one method, especially as the same applies to other ocular micrometers. It is first necessary to standardize the eye-piece micrometer. This is effected by bringing the scale into focus, placing a millimeter or inch micrometer upon the stage, focussing, and then adjusting the two scales so that the zero of the eye-piece scale shall exactly correspond with one of the lines of the stage micrometer. Determine how many divisions of one are equal to an even number of divisions of the other when a simple calculation will give the value of each division of the ocular scale in terms of the stage micrometer. Thus suppose that 0.5 mm. of the stage micrometer are equivalent to 46 divisions in the eye-piece, each division of the latter is therefore equal to 0.01087 mm. Replacing the stage micrometer by the object to be measured it is found that its length is equal to 30 of these divisions, or in other words is 0.326 mm. in that dimension. It is obvious that this value for the divisions of the eye-piece micrometer is good only while the conditions remain the same.



5



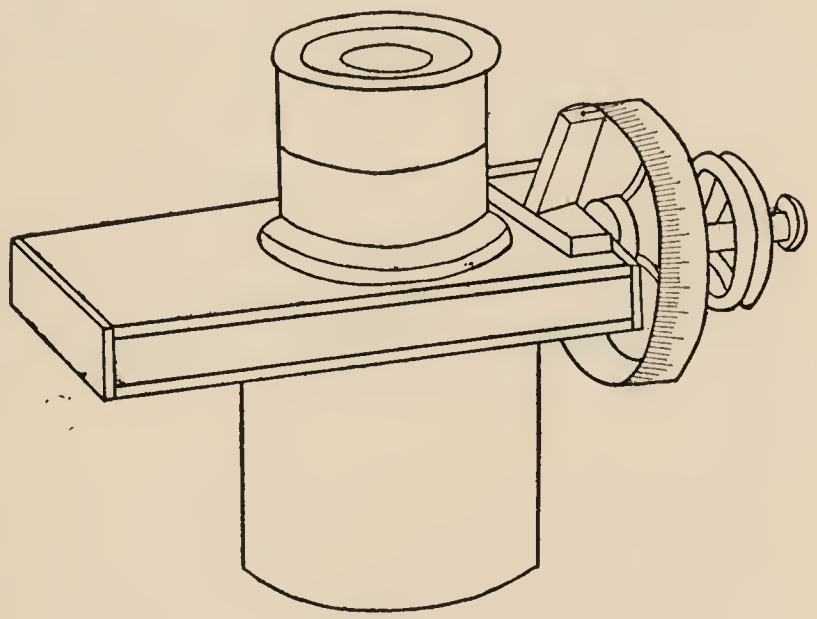
6

FIG. 5. JACKSON'S EYE-PIECE MICROMETER.
FIG. 6. JACKSON'S MICROMETER EYE-PIECE.

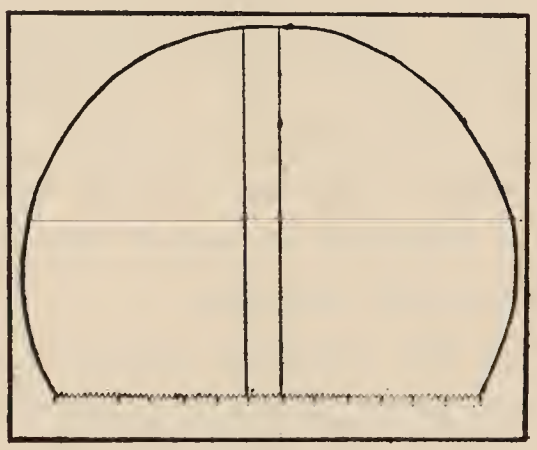
The form of micrometer eye-piece devised by Jackson has been largely replaced by one in which the scale, an arbitrary one, on a circular glass is fixed at the focus of an ordinary negative eye-piece.

The micrometer eye-pieces with movable scales are represented by the cobweb micrometer invented by Ramsden, and first used for telescopes. Fig. 7 shows the eye-piece, and Fig. 8 the cobwebs and comb.

It consists of a positive eye-piece, in the focus of which two fine parallel wires or cobwebs are stretched across the field. One of these wires is fixed at the centre of the field, while the other can be moved by means of a screw, having 50 or 100 threads to the inch, and whose outer end is attached to a graduated disc, usually divided into 100 parts. On the lower side of the field is a metal comb having notches which correspond with the threads of the screw. This comb serves to register entire revolutions of the screw, while fractional parts are indicated by the disc. It is necessary to ascertain the value of each revolution or part of a revolution of the screw in the manner already described. The objection to this micrometer is that the measurement of an object cannot be made in the centre of the field.



7



8

FIG. 7. RAMSDEN'S MICROMETER EYE-PIECE.
FIG. 8. THE SCALE OF THE SAME.

Among other modifications of this micrometer is one by Nelson, in which the fixed wire was placed five notches from the centre of the field on the side furthest from the screw head; and later the same microscopist still further improved it so that both wires could be moved *en bloc* across the field, and also by adopting a compensating eye-piece.

Zeiss has devised a screw micrometer eye-piece for objects which occupy a large part of the field. It consists of a Rams-

den eye-piece having a glass plate with crossed lines, and the whole can be moved across the field by means of the micrometer screw. A compensating eye-piece can be employed instead of the Ramsden for use with apochromatic lenses.

The ease and accuracy of measuring objects by means of photomicrography is familiar to all who have had experience with this method. We believe Dr. Woodward preferred this to all others for the measurement of blood corpuscles. By substituting the stage micrometer for the object its image is thrown upon the ground glass, and then can be measured or photographed as desired. Measurements should be made upon the negative and not on the positive print obtained from it.

Regarding the unit of measure to be adopted in micrometry it may be said that the micron, or the $\frac{1}{1000}$ of a millimeter, is now generally adopted in scientific work. The standard was proposed by Harting in 1859, who called it a micro-millimeter. This term was afterward changed to micron by Listing, and the sign μ adopted as an abbreviation. The micron is equivalent to nearly $\frac{1}{25000}$ of an inch.

The determination of the magnifying power of a microscope is effected in much the same way as the measurement of microscopic objects.

One of the simplest plans is that suggested by Hooke, to which reference has already been made. If a stage micrometer is used in place of the object a comparison can be readily made between the image of any portion of the scale and the ruler placed at the same distance. Thus if $\frac{1}{100}$ of an inch on the stage micrometer is equivalent to $\frac{6}{10}$ of an inch on the ruler, the magnification is 60 diameters.

Another simple and accurate method is to use some form of the camera lucida. The microscope is arranged as for drawing, the paper being placed 10 inches from the eye-piece. It is important to note that in *measuring* objects by the camera lucida it is immaterial what this distance is, since the object bears the same ratio to the scale at all distances.

A micrometer is then placed upon the stage and its graduations projected upon the paper and measured. The mag-

nifying power is found by dividing the distance measured on the paper by the division of the stage micrometer used. Thus, if $\frac{1}{100}$ of an inch of the scale equals three inches on the paper, then the magnifying power is 300 diameters.

Other methods have been suggested, but they possess no advantages over those given.

A MODERN MICROSCOPIC OBJECTIVE.

BY HENRY ORFORD.

(*Read October 18th, 1895.*)

The objective has been ever a source of discussion for microscopists, and also the most difficult part of the instrument with which the optician has to deal. Years back, when the instrument was known only to a few scientists, the question of the construction of the objective was taken up, and many related untenable theories were advanced. Such is the diffraction theory. If this is correct, as some prominent microscopists still believe, all the previous impressions of the older optical principles must be disregarded, also all the writings of the optical physicists, before the diffraction theory became floated, must be put down as useless.

Dr. Goring pointed out that a larger lens, meaning one with more aperture, would separate the minute markings of scales on a test slide, and that he could get better results with an unachromatized objective of larger aperture than he could with the achromatic systems of small aperture of that day. And since that time there has been an ever-increasing desire to enlarge the aperture of objectives. It was soon found out, however, that with every degree of enlarged aperture attempted, the delicacy of the aberrations to be corrected were also enormously increased. So that the computation of a modern objective is truly a gigantic undertaking.

Some years later a fluid was suggested to be used between the anterior lens and the cover glass, to prevent the great loss of light due to refraction. And I believe Mr. Tolles constructed lenses with which he used balsam as the immersing medium. Before this, however, Powell and Lealand had constructed very fine water immersion lenses. Since Dr. Abbe's adoption of cedar oil this has generally come into use, and other immersion fluids, some of which possibly have special uses, have been gradually discontinued. Cedar oil was

adopted by Dr. Abbe only after exhaustive experiment, and it stands without a rival in dispersive suitability.

For the purpose of vision an image must be formed on the retina of the eye, and the purpose of the compound microscope is to form an enlarged image of minute structures that are indistinguishable by the unaided eye. Images are formed by rays, and every single ray has the power of forming an image. If such were not the case the lens would have no image-forming power itself.

To show this make the pinhole experiment. Light a candle in a dark room. Arrange a sheet of cardboard two feet distant, and between the two put a blackened card punctured with a pinhole. We see then an inverted image of the flame on the white card. If we make the hole in the card larger, we get a brighter but no longer a sharp image, because now it is really a number of images, formed by rays that cross at different points of the larger hole. These rays of light, each having an image-forming power when passing through a lens, are all converged together to a focus, and the image formed will, of course, be many times brighter than that of the single ray which passed through the blackened card. The lens then determines the place where the cones of diverging rays from an object shall begin to converge, and its position marks the place where refraction occurs, and also marks the point where the rays cross and invert the image. So the objective only converges and combines masses of rays, each one of which has the power of forming an image. It is thus obvious that the increased aperture of a lens means greater illumination. As stated before, Dr. Goring found better resolution with an unachromatized combination of large aperture than with an achromatic system of small aperture.

The relation between aperture and resolution was shown by a simple experiment of Lord Raleigh. Each person was furnished with the apparatus required. It consisted of a piece of fine wire gauze, and a black card with two pinholes, one very small, and the other made with a thick pin. Holding the gauze to the light and looking at it through the small pinhole, gradually moving it further off, at a certain distance the

meshes would become invisible. Moving the card along till the larger pinhole was in front and close to the eye, instantly the meshes would become visible again. It will be seen at once that the greater aperture allowed to the eye brought them into view.

That it was not merely more light that brought the image of the meshes distinctly to the eye can instantly be proved by another simple experiment. Get a piece of blackened glass, and make two scratches on it about $\frac{1}{16}$ of an inch long, one vertical and the other horizontal. Hold the gauze so that the wires are horizontal and vertical to the scratches on the glass, and, when the proper distance is found, it will be seen that the vertical scratch will not show the vertical wires, but will clearly show the horizontal ones, whilst the horizontal scratch will only show the vertical wires. The amount of light that passes through each scratch is exactly the same. So it will be seen it is the aperture diameter, which crosses the wires, that determines the distance at which they can be resolved. We then see that the rays form the image, and the aperture determines the resolution. This is the same whether applied to a deep microscope objective, resolving a fine diatom, or to a telescope dividing a double star. And whether the diffraction theory does or does not apply to either of these cases, the very same numerical law of relation between aperture and resolution applies to all.

Every microscopist knows the Abbe diffraction theory, and how it took the microscopical world by storm; and also how the theory has been successively modified, as error after error has been demonstrated. Abbe maintained that the image was not dioptically formed, but was an interference image. This he demonstrated with a fine diatom of about 93,000 striations to the inch, using a lens of 1.26 N. A., and very oblique illumination, till the narrow pencil he used appeared on the margin of the back of the lens. On the opposite side of the lens appeared a blue light, and when this was covered up, every vestige of markings disappeared, and only the shell of the diatom was seen. By his excessive oblique light he had increased the aperture of his lens, but directly his narrow

cone was interfered with all benefit was lost again. Not so with a wide cone. I have many times put a ring around the back of a lens, and allowing the central and most marginal rays only to enter the microscope, even when half of the few marginal rays were obstructed, the markings of the image yet remained.

One thing the diffraction theory did, it settled forever striving after useless magnifying power in objectives, such as $\frac{1}{40}$ and $\frac{1}{50}$ of very small aperture, and led opticians to construct lower powers $\frac{1}{8}$ and $\frac{1}{12}$ of large aperture, from which more could be gained.

That the true resolution of an object is effected by a wide cone instead of a narrow one is now beyond question, consequently the laws of optics are just in the same place as when demonstrated by the older writers. But having this extreme oblique illumination and resolving of the striæ is a true image formed, such as can be obtained with a dioptric or wide cone? It will be found both by observation and measurement that the diffraction image is utterly false. The striations are seen as considerably finer than the true structure, also markings are shown of an elongated form. The diffraction spectra can only be shown by very narrow pencils of light. And the narrower the pencil the sharper the so-called image. But to get a true image we must employ a large cone. We saw with the pinhole that a ray formed an image, but that image had no focus. When we put a lens in its place there is a definite focus, because, at one point only, a diverging cone of rays from a point in the object is converged into another cone, whose apex is as small and sharp an image of the point as the aperture and correction permit.

Any such image, formed by rays first diverging from a point, and then converged by the corrected refraction of a lens to the image point, is a dioptric image, and every real microscope image is dioptric. What we want is an objective that will give a true dioptric image, coupled with a good condenser having an aplanatic cone. With these the narrow cone theory is intolerable. Given objectives and condensers good

enough, the best results in definition and resolution of fine structure have been with wide cones.

As a manufacturer of lenses of some years' standing, as well as a worker with a microscope, I have had ample opportunities to carry out many experiments, which are almost impossible for the ordinary microscopist to imagine, and I have also had free access to almost any lens of other makers which I desired to examine. A microscope objective then should have large aperture, but that aperture is worse than useless unless it is properly corrected.

Some time since I carried out a series of experiments with the aperture of lenses relating to correction. I constructed a lens of 1.30 N. A., and at the back fitted an iris diaphragm, which could cut out all the marginal rays. Trying it on a test diatom I found no difference appeared when I cut the aperture down to 1.1 N. A. Below that the minute markings disappeared. The objective showed the markings just as well with the aperture of 1.1 N. A. as with 1.30 N. A., so of course it proved that the marginal rays were not sufficiently corrected. I may say that this could only be observed when using a condenser with an aplanatic cone. When used with an Abbe condenser, with its enormous aberration, these facts were indistinguishable. Correcting the lens yet farther, and using a perfectly achromatized condenser, the image was remarkable.

The fact was soon impressed on me that for very fine resolution aperture is useless unless it is corrected in all its zones. Otherwise it had better be cut away. For as cones are enlarged faults of objectives are revealed, and as the objective is more perfectly corrected faults in the cone stand out more clearly. Consequently for high resolution the solid cone will no longer suffice.

With increased and perfectly corrected aperture, the flatness of field should be as important to the maker. But this is very difficult to correct, and it has always been taken for granted that definition and flatness were incompatible. A glance at my objectives will be a proof to the contrary.

PROCEEDINGS.

Meeting of May 3d, 1895.

The President, Dr. Edw. G. Love, in the chair.

Twelve persons were present.

Messrs. James M. B. Hard, Joseph T. Bedford and George T. Hughes were elected resident members of the Society.

OBJECTS EXHIBITED.

1. Salivary glands from head of Honey-bee: by Edw. G. Love.

2. Photomicrographs of isolated scalariform vessels of *Pteris aquilina:* by Edw. G. Love.

3. Circulation of blood in tail of Tadpole: by Max Meyer.

4. Pygidium of Flea: by Thomas B. Briggs.

5. *Pandorina*, *Scenedesmus* and other organisms, filtered from the water supply of New-York City: by Thomas B. Briggs.

6. *Carchesium* on *Melicerta ringens*, living: by James Walker.

7. *Conochilus volvox*, living, containing unusually large spiny revolving eggs: by James Walker.

8 Posterior leg of Honey-bee with pollen, shown by parabolic illuminator: by Henry C. Bennett.

Dr. Love explained that the striking difference in the intensity of the prints of the scalariform vessels in his photomicrographs was due to the colors used in staining the original objects. On the slide the vessels were mounted alternately stained yellow and blue. Those stained blue gave the light prints, and the yellow gave the dark prints.

Mr. Briggs gave this account of his first exhibit:

"The pygidium of the flea is composed of two lobes, and displays thirty-two to thirty-eight long and stiff hairs implanted in the centre of as many areolæ, and each is surrounded by a row of small cuneiform elevations. The spaces between the areolæ are covered with small spines.

"Van Heurck says that it is an excellent test to judge of the defining power of an objective. That he has employed it for this purpose for more than twenty-five years. And that an excellent objective ought to show the areolæ clearly defined in all their parts, and the elevations ought to appear cuneiform, and not round, as they are drawn by Dujardin. Moreover, the color of the object ought to be a very clear brownish yellow, without the slightest appearance of milkiness."

Meeting of May 17th, 1895.

The President, Dr. Edw. G. Love, in the chair.

Twenty-three persons present.

Mr. George H. Blake reported in behalf of the Committee on Annual Exhibition. The report was accepted and the Committee discharged, with thanks.

Mr. J. D. Hyatt donated a gavel for the use of the Society, which was a beautiful specimen of his own skill in wood turnery. This gavel was accepted by the President, with an appropriate expression of thanks in behalf of the Society.

Dr. Carlton C. Curtis addressed the Society on "Some interesting features of well-known Plants of New-York Harbor." This address was illustrated by black-board drawings, and by objects under microscopes, and is published in this volume of the JOURNAL, p. 63.

OBJECTS EXHIBITED.

1. *Calothrix:* by C. C. CURTIS.

2. *Ulothrix:* by C. C. CURTIS.

3. Three methods of reproduction of *Polysiphonia ucerolâta:* by C. C. CURTIS.

4. Organisms from filterings of Croton water: by T. B. BRIGGS.

5. Transverse and longitudinal sections of leaf of *Ficus elastica* Roxburgh, showing cystolith cells: by J. L. ZABRISKIE.

Mr. Zabriskie remarked upon his exhibit, that a recent examination of the leaf of this plant opened a surprise on account of the evident great number of the contained cystoliths.

These well-known cystoliths are concretions of cellulose, permeated by fine granules of carbonate of lime, forming a body resembling a bunch of grapes, suspended by a slender stem in certain large cells of the hypoderm of the upper surface of the leaf. The epiderm consists of layers of globular thick-walled cells. The hypoderm succeeds this consisting of four to six layers of larger cells, and in certain interspersed colossal cells of this hypoderm, at least four times the size of any of their neighbors, the cystoliths are suspended.

For the transverse sections a piece of the leaf was taken about $\frac{1}{10}$ of an inch in width, from the centre and parallel with the small veins of the leaf. This fragment was held between two pieces of soft cork, and sections were cut in the microtome across the small veins and about $\frac{1}{800}$ of an inch in thickness. If sections less in thickness were made the cystoliths were dragged out of their cells by the edge of the knife.

For the longitudinal sections a strip about $\frac{1}{2}$ of an inch in width was taken from a similar portion of the leaf, and bent in cylindrical form over the finger. From this convex surface successive elliptical sections were cut free hand as thin and even as possible. The first sections would contain scarcely anything more than the nearly transparent epiderm. But the succeeding sections extended deeper into the tissues, showing very distinctly in succession from the edges inward the four kinds of cells—epiderm, hypoderm (interspersed with cystolith cells), and chlorophyll. The cystoliths generally were torn out by the knife, leaving their large cells prominent and unmistakable.

With the camera lucida $\frac{1}{10}$ of an inch square, magnified thirty diameters, was laid off on drawing paper, and was divided by lines into one hundred squares, each representing $\frac{1}{100}$ of an inch square. Then a portion of a longitudinal section of a leaf, under the same magnification, was sketched upon these squares. It was found that on an average 24

squares contained 27 cystoliths, giving 11,266 cystoliths to the square inch. On this calculation, if a medium sized leaf contains 40 square inches of surface, then the same leaf contains 450,642 cystoliths.

Meeting of June 7th, 1895.

The President, Dr. Edw. G. Love, in the chair.

Twenty-one persons were present.

Mr. James Walker addressed the Society on "A New Method of Mounting Minerals for the Microscope, and a New Mineral Holder." Mr. Walker said, in effect, that for twelve years he had experimented with different forms of boxes suitable for this purpose. Finally he found one company which manufactured a shallow circular brass box, with a close fitting brass cover, about one inch in diameter. This box he found more satisfactory than any other used. On the lathe he cut out nearly all the horizontal metal of the cover, leaving a narrow flat rim, on the under side of which he cemented an ordinary circular cover glass. A blackened cork foundation was cemented in the bottom of the box, and the mineral specimen was cemented on this cork, or, in certain instances embedded in balsam on the under surface of the above-mentioned cover glass. The cement employed for this purpose being composed of shellac and Venice turpentine dissolved in alcohol.

Mr. Walker also exhibited and explained a holder, of his own contrivance, for manipulating such boxes and covers containing specimens upon the stage of the microscope—a brass plate with a circular opening, containing a flanged ring as a seat for the box or its cover, two concentric milled head shafts communicating two motions to the ring—a rotating motion and a tilting motion.

Mr. Walker also exhibited his trays for storing the boxes—shallow trays with lids, each tray containing twelve boxes, lateral movement of the boxes being prevented by strips glued to the bottom of the tray.

The President gave an interesting review of Nelson's article in the late issue of the *Journal of the Royal Microscopical Society*, on the reversal of image by different forms of camera lucida, contrasting the operation of forms of camera by Abbe, Beal, Wollaston and Nelson.

OBJECTS EXHIBITED.

1. Circular metal boxes for preserving and exhibiting minerals: by JAMES WALKER.

2. A new holder for manipulating such boxes on the microscope stage: by JAMES WALKER.

3. Trays for storing such boxes: by JAMES WALKER.

4. Native copper in quartz, Paterson, N. J.: by FREDERICK KATO.

5. Hydromagnesite, Hoboken, N. J.: by FREDERICK KATO.

6. Sori of ferns; *Dicksonia squamosa*, New Zealand; *Marattia froxinea*, New Zealand; *Cetrach officinale:* by GEORGE E. ASHBY.

7. Trichomes of leaf of *Eccremocarpus setigera:* by EDW. G. LOVE.

8. Spores of *Polypodium vulgare*: by EDW. G. LOVE.

FROM THE SOCIETY'S CABINET.

9. Leaf of *Eleagnus.*

10. Leaf of *Deutzia scabra.*

11. Leaf of *Onosma taurica.*

MEETING OF JUNE 21ST, 1895.

The President, Dr. Edw. G. Love, in the chair.

Thirteen persons present.

OBJECTS EXHIBITED.

1. Two tubes of the new valuable abrasive, Carborundum, green and blue: by EDW. G. LOVE.

2. A thirty minutes' filtration of Croton water, exhibiting *Hydra*, *Volvox*, *Closterium*, *Pediastrum*, *Pandorina*, *Vorticella*: by T. B. BRIGGS.

3. Pistil and pollen of Geranium: by JAMES M. B. HARD.
4. Pollen of Mallow: by JAMES M. B. HARD.
5. Section of hair of Whale: by CHARLES S. SHULTZ.
6. Hair of *Ornithorhyncus:* by CHARLES S. SHULTZ.
7. Section of hair of Elephant: by CHARLES S. SHULTZ.
8. *Tingis hyalina:* by GEORGE E. ASHBY.
9. Fairy fly, *Alaptus minimus*, a degraded hymenopteron: by GEORGE E. ASHBY.
10. Photomicrographs. Cells in section of root of Geranium; Section of Dodder on *Impatieus fulva;* Section of endosperm of *Ricinus* showing aluerone grains: by EDW. G. LOVE.
11. A focusing arrangement for use in photomicrography: by FRANK D. SKEEL.

Dr. Skeel explained his focusing arrangement, the main characteristics of which were, a metal rod extending the entire length of the camera bed, the rod being supported at intervals by hangers consisting of small metal brackets projecting latterly from the bed, each hanger having a semicircular notch in its upper side acting as a seat for the rod, and also a small metal hook slightly clasping the upper surface of the rod to retain the latter in position, the rod being furnished at the end near the microscope with a small pulley carrying a thread belt, this belt passing over the grooved milled head of the fine adjustment of the microscope, all giving convenient and steady focusing, without any strain on the fine adjustment.

ERRATA.—In Mr. Cox's paper, in the last number of this Journal, on page 83, fifth line from the bottom, change 1/100,000 to 1/90,000; in the next line and in the last line change 147° to 140°; also in the last line change (N.A. 1.04) to (N.A. 0.94); and make corresponding corrections at the top of page 84.

PUBLICATIONS RECEIVED.

American Monthly Microscopical Journal: Vol., XVI., Nos. 3–9 (March–September, 1895).

The Microscope: Vol. III., Nos. 3–9 (March–September, 1895).

Psyche: Vol. VII., Nos. 228–234 (April–October, 1895).

The Observer: Vol. VI., Nos. 4–8 (April–August, 1895).

Insect Life: Vol. VII., Nos. 4, 5 (March–July, 1895).

Bulletin of the Torrey Botanical Club: Vol. XXII., Nos. 3–9 (March–September, 1895).

Missouri Botanical Garden, Sixth Report (1895).

Anthony's Photographic Bulletin: Vol. XXVI., Nos. 4–10 (April–October, 1895).

School of Mines Quarterly: Vol. XVI., Nos. 2–4 (January–July, 1895).

San Francisco Microscopical Society, Proceedings: May 1, April 17, 1895.

Proceedings of the Natural Science Association of Staten Island: Vol. IV., Nos. 15–19 (March–September, 1895).

American Museum of Natural History, Bulletin: Vol. VI. (1894); Annual Report (1894).

Academy of Natural Sciences of Philadelphia, Proceedings: 1895, Part 1.

California Academy of Sciences, Proceedings: Vol. IV., Part 2 (April, 1895).

Academy of Science of St. Louis, Transactions: Vol. VI., No. 12—Vol. VII., No. 3 (April, 1894–February, 1895).

Journal of the Franklin Institute: Vol. CXXXIX., No. 832—Vol. CXL., No. 838 (April–October, 1895).

Bulletin of the Museum of Comparative Zoölogy: Vol. XVI., No. 15—Vol. XXVIII., No. 1 (April–July, 1895).

New York State Museum, Report 47 (1894).

Scientific Laboratories of Denison University, Bulletin: Vol. VIII., Parts 1, 2 (May, 1893, June, 1894).

Proceedings of the Portland Society of Natural History: Vol. II., Part 3 (1895).

Minnesota Botanical Studies: Bulletin No. 9, Part 6 (August, 1895).

Bulletin of Laboratories of Natural History of State University of Iowa: Vol. III., No. 3 (March, 1895).

Colorado Scientific Society, Proceedings: Vol. IV. (1893). Six addresses (1894, 1895).

Geological Survey of Alabama, Report on the Geology of the Costal Plain (1894).

New York Academy of Medicine, Transactions (1893).

Tufts College Studies: No. 4 (September, 1895).

Journal of the Elisha Mitchell Scientific Society: Vol. XI., Part 2 (1894).

United States Department of Agriculture. Division of Entomology, Technical Series No. 1 (1895).

Cornell University Agricultural Experiment Station. Bulletins, Nos. 82–98 (December, 1894–July, 1895.)

Michigan State College Experiment Station. Bulletins, Nos. 118–126 (January–June, 1895).

Alabama Agricultural Experiment Station. Bulletins, Nos. 61–64 (January, February, 1895).

Iowa Experiment Station. Bulletin, No. 28 (1895).

Texas Experiment Station. Bulletins, Nos. 33, 34 (December, 1894, February, 1895).

Geological Survey of Canada. Report: Vol. VI. (1892–93).

The Ottawa Naturalist: Vol. IX., Nos. 1–6 (April–September, 1895).

The Canadian Record of Science: Vol. VI., Nos. 1, 2 (January, April, 1894).

Journal of the Royal Microscopical Society. Parts 2–4, 1895.

International Journal of Microscopy and Natural Science: Vol. V., Nos. 26, 27 (April, July, 1895).

Journal of the Quekett Microscopical Club: Vol. VI., No. 36 (March, 1895).

Transactions of the Natural History Society of Glasgow: Vol. IV., Part 1 (1894).

The Naturalist: Nos. 237–243 (April–October, 1895).

Société Belge de Miscroscopie. Annales: Vol. XVIII., No. 2; Vol. XIX., No. 1 (1894, 1895).

Société Royale de Botanique de Belgique. Bulletin: Vol. XXXIII., No. 2; Vol. XXXIV., No. 1 (1894, 1895).

Société d'Études Scientifiques d'Angers. Bulletin: Vol. XXIII. (1893).

Société les Amis des Sciences et Arts de Rochechouart. Bulletin: Vol. IV., Nos. 4–6 (September, 1894–January, 1895).

Feuille des Jeunes Naturalistes: Vol. XXV., Nos. 294–300 (April–October, 1895).

Société Helvétique des Sciences Naturelles. Compte Rendu, Session 76 (1893). Actes, Session 76 (1893).

The Victorian Naturalist: Vol. XI., No. 10—Vol. XII., No. 3 (January–June, 1895).

Société des Naturalistes de Kiew. Memoires: Vol. XIII., Nos. 1, 2 (1894).

Société Imperiale des Naturalistes de Moscou: 1894, Nos. 2–4.

Académie d'Hippone. Fascicule trimestriel (1895).

Königl. Böhmische Gesellschaft der Wissenschaften, Prag. Sitzungsberichte (1894); Jahresbericht (1894).

Naturforschenden Gesellschaft des Osterlandes, Altenburg. Mitteilungen: Vol. VI. (1894).

Wissenschaftlicher Club, Wien. Monatsblätter: Vol. XVI., Nos. 6–12 (March–September, 1895). Ausserordentliche Beilage: Vol. XVI., No. 2 (January, 1895). Societatum Litteræ: Vol. VIII., No. 10–Vol. IX., No. 3 (October, 1894–March, 1895). Helios: Vol. XII., Nos. 7–12 (October, 1894–March, 1895).

Nuovo Giornale Botanico Italiano: Vol. II., Nos. 2, 3 (April, July, 1895).

Bullettino della Società Botanica Italiana: 1895, Nos. 2–5.

La Notarisia: Vol. IX., No. 6 (1894).

Revista cel Museo de la Plata: Vol. V., Vol. VI., Part 1 (1894).

Revista Chilena di Hijiene, Santiago: Vol. I., Nos. 2, 3 (September, October, 1894).

Hijiene Colonial en Cuba. Discurso Commemorative de la Fundacion de la Real Academia de Ciencias, Habana. From the Author, Dr. Antonio de Gordon y de Acosta (1895).

Six reprints relating to the Anatomy of the Fomicidæ: On the nest of *Vespa crabro* L. From the Author, Charles Janet.

The Brooklyn Medical Journal: Vol. IX., Nos. 4–10 (April–October, 1895).

The Universal Medical Journal: Vol. III. (March–September, 1895).

Pacific Medical Journal: Vol. XXXVIII., Nos. 4–10 (April–October, 1895).

The National Druggist: Vol. XXV., Nos. 4–10 (April–October, 1895).

Australian Museum. Report (1894).

Johns Hopkins University Circulars: Vol. XIV., Nos. 118–120 (April–July, 1895).

Conspectus Générique des Diatomées. From the Author, Dr. Henri Van Heurck (1895).

Le Diatomiste: Vol. II., Nos. 8, 9 (March, June, 1895).

INDEX OF VOL. XI.

PAGE

Address, Presidential 54
Algæ of New-York harbor 63
Amber, Insects in 86
Amphioxus lanceolatus, Eggs of 33
Annual reports 54
—— exhibition 90
Anolis, Embryos of 33, 89
—— *principalis*, Change of color by 55
Aperture, Relation of, to determination 74
Armor, Dermal, of the sturgeon 1
ASHBY, GEORGE E. Gum copal 58, 87
—— Spiders in gum copal 59

BALEN, A. D. *Branchippus stagnalis* 35
BENNETT, HENRY C. Preparations of the frog 32
—— *Cocconeis vitrea* 89
Box, A new mineral, and stageholder 114
Branchippus stagnalis 35
BRIGGS, THOMAS B. Pygidium of flea 111
Brunia Californica 52, 88
By-laws amended 54

Camera lucida, Action of 115
Chameleon, Change of color by 55
Cicada septendecim, Notes on 37
Clarification 22
Clarifier, A 22
Cocconeis vitrea 89
Committee on nominations 34
—— on by-laws 54
—— on admissions 57
—— on publications 57
—— on annual exhibition 112
Copal, Gum 58, 86
—— Insects in 58, 59
—— Bubbles in 59
—— Polishing 59
COX, CHARLES F. Change of color by chameleon 55
—— Relation of aperture to determination of minute structure 74

PAGE

Cross lines of telescopes 96
CUNNINGHAM, K. M. On a new diatom 35
CURTIS, CARLTON C. Plants of New-York harbor 63
Cystoliths of *Ficus elastica* 113

Delegates to council of Scientific Alliance 57
Dermal armor of the sturgeon 1
Development of the modern microscope 87
Diatom, A new, from Alabama 35
—— A new, from California 52, 88
—— The, *Cocconeis vitrea* 89
Donation: by J. D. HYATT 112

Eggs of *Amphioxus lanceolatus* 33
Election of officers 53
Errata 116
Exhibition, Annual 90

"Fibre Chamois" 58
Ficus elastica, Cystoliths of 113
Flea, Pygidium of 111
Focusing arrangement, Photomicrographic 116
Formaldehyd as a preservative 33
Frog, Preparations of the 32

Gavel, Donation of a 112
Gum copal 58
—— Insects in 58, 59
—— Bubbles in 59
—— Polishing 59

Insects in gum copal 58
—— in amber 86

KOSMAK, G. W. Dermal armor of the sturgeon 1
—— Eggs of *Amphioxus lanceolatus* 33
—— Præmaxillary embryonic tooth of reptiles 33
—— "Fibre Chamois" 58

LEGGETT, F. W. Insects in gum copal 58
—— Parasite of oyster 90
Leitz, E. The Manufactory of 52
Leopard moth 30
LOVE, EDW. G. Notes on Cicada septendecim 37
—— Micrometry 97
—— Action of camera lucida 115

PAGE

MARTIN, DANIEL S. Insects in copal and amber 86
Micrometry 97
Microscope, Development of the modern 87
—— objective, A modern 106
Mineral box and rotating stage holder, A new 114

Nominations, Committee on 34

Objective, A modern microscope 106
Officers, Election of 53
ORFORD, HENRY. A modern microscope objective 106
Oxide of zinc 27
Oyster, Parasite of 90

Parasite of oyster 90
Phagocytoblast, Protonuclein, the 34
Photomicrographic focusing arrangement 116
Plants of New-York harbor 63
Præmaxillary tooth of reptiles 33
Preservative, Formaldehyd as a 33
Presidential address 54

PROCEEDINGS:

Meeting of October 5th, 1894 28
19th 29
November 2d 31
16th 32
December 7th 33
21st 34
January 4th, 1895 53
18th 54
February 1st 57
15th 59
March 1st 86
15th 87
April 5th 88
19th 95
May 3d 111
17th 112
June 7th 114
21st 115

Pronuclein, the Phagocytoblast 34
Publications received 60, 117
Pygidium of the flea 111

Rana esculenta, Preparations of 32
Reports, Annual 54

PAGE

RIEDERER, L. Formaldehyd as a preservative..... 33
—— Præmaxillary embryonic tooth of *Anolis*..... 89

SCHULTZE, E. A. Clarification and a new clarifier..... 22
—— Remarks on *Triceratum Zabriskiei*..... 57
Scientific Alliance, Delegates to..... 57
Seventeen-year Cicada, Notes on..... 37
SCHULTZ, CHARLES S. The manufactory of E. Leitz..... 32
—— Presidential address..... 54
SKEEL, FRANK D. Development of the modern microscope..... 87
—— Cross wires of telescopes..... 96
—— Photomicrographic focusing arrangement..... 116
Spiders in gum copal..... 59
STOKES, ALFRED C. On *Vasicola annulata*..... 47
SUMMERS, T. O. Pronuclein, the phagocytoblast..... 34

TERRY, WILLIAM A. A new diatom from California..... 52, 88
Tooth, Præmaxillary embryonic, of reptiles..... 33

Vasicola annulata..... 47

WALKER, JAMES. Polishing gum copal..... 59
—— Insect in amber..... 87
—— A new mineral box and stage holder..... 114
Wires, Cross of telescopes..... 96

ZABRISKIE, J. L. European Leopard Moth..... 30
—— Cystoliths of *Ficus elastica*..... 113
Zinc Oxide of, accidentally crystallized..... 27

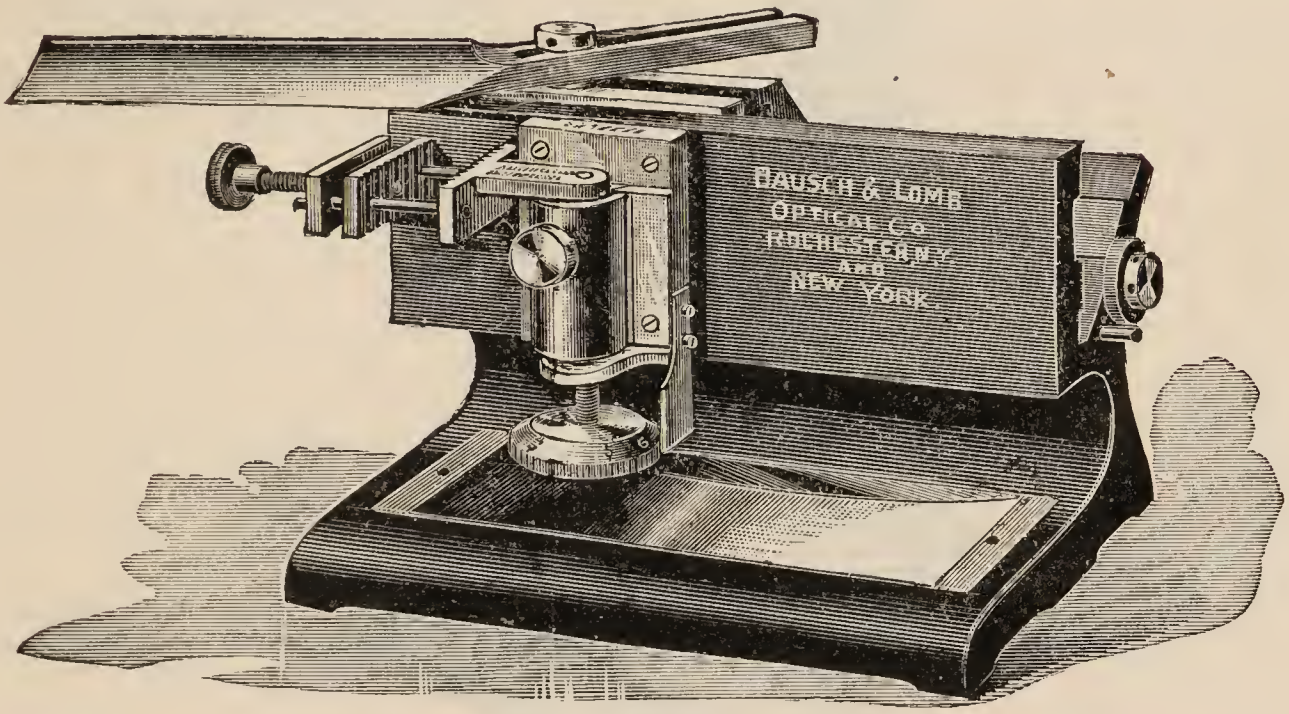
WELLCOME LIBRARY INSTITUTE

AMERICAN

Microscopes, Objectives, and Accessories

MANUFACTURED BY

BAUSCH & LOMB OPTICAL CO.



STUDENT MICROTOME, $18.00.

Do not fail to procure the 13th edition catalogue (120 pages), entirely revised, issue June, 1892, comprising **Variety of new Apparatus for the Microscopist.** It will be mailed free to any address upon application.

FACTORY AND MAIN OFFICE:

515–543 North St. Paul St.,

ROCHESTER, N. Y.

P. O. Drawer 1033.

BRANCH OFFICE:

130 Fulton Street,

NEW YORK CITY,

P. O. Box 432.

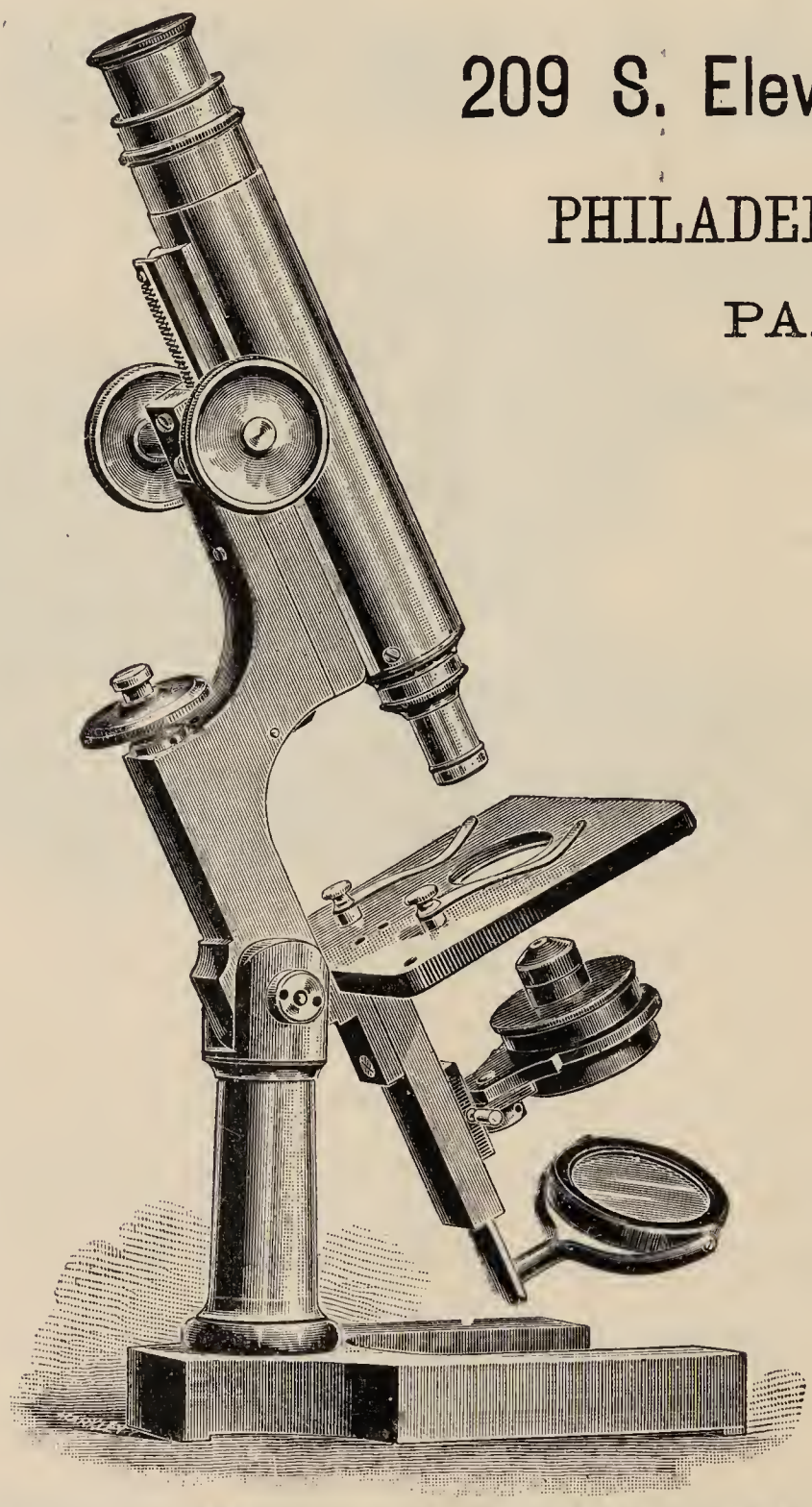
ESTABLISHED IN 1853.

JOSEPH ZENTMAYER,

OPTICIAN.

—MANUFACTURER OF—

Microscopes and Microscopical Apparatus,



209 S. Eleventh St.,

PHILADELPHIA,

PA.

ZENTMAYER'S AMERICAN-CONTINENTAL STAND.

NEW YORK AGENCY,

MEYROWITZ BROS.,

Fourth Avenue and 23d Street.

WM. WALES, FORT LEE, N. J.

SEND FOR CATALOGUE.

JOURNAL

OF THE

NEW-YORK

MICROSCOPICAL SOCIETY

VOLUME XI.

NEW-YORK :
PUBLISHED FOR THE SOCIETY,
QUARTERLY.